1. OPERATIONAL PROCEDURES

1.1 GENERAL

The Joint Typhoon Warning Center (JTWC) provides a variety of routine products and services to the organizations within its area of responsibility (AOR), including:

1.1.1 SIGNIFICANT TROPICAL WEATHER ADVISORY — Issued daily or more frequently as needed, to describe all tropical disturbances and their potential for further development during the advisory period. Separate bulletins are issued for the western Pacific and the Indian oceans.

1.1.2 TROPICAL CYCLONE FORMATION ALERT — Issued in a specified area when synoptic, satellite, or other germane data indicate that the development of a significant tropical cyclone is likely within 24 hours.

1.1.3 TROPICAL CYCLONE/ TROPICAL DEPRESSION WARNING — Issued periodically throughout each day to provide forecasts of position, intensity, and wind distribution for tropical cyclones in JTWC's AOR.

1.1.4 PROGNOSTIC REASONING MESSAGE — Issued with warnings for tropical storms, typhoons, and super typhoons in the western North Pacific to discuss the rationale for the content of the specific JTWC warning.

1.1.5 PRODUCT CHANGES — The contents and availability of the above JTWC products are set forth in USCINCPACINST 3140.1W. Changes to USCINCPACINST 3140.1W and JTWC products and services are proposed and discussed at the annual U.S. Pacific Command (PACOM) Tropical Cyclone Conference.

1.2 DATA SOURCES

1.2.1 COMPUTER PRODUCTS — Numerical and statistical guidance are available from the USN Fleet Numerical Meteorology and Oceanography Center (FLENUMETOCCEN) at Monterey, California. FLENUMETOCCEN supplies JTWC with analyses and prognoses, from 0000Z and 1200Z synoptic data, at the surface, 850-mb, 700-mb, 500-mb, 400-mb, and 200-mb levels. The charts provided include: deep-layer-mean winds, wind shear, geopotential height-change, surface pressure, streamlines, and sea surface temperature, as well as many other routine products. These products, along with selected ones from the National Centers for Environmental Prediction (NCEP) Suitland, the European Centre for Medium-Range Weather Forecasts (ECMWF), and the Japanese Meteorological Agency (JMA) are received as electronic files via networked computers, and by computer modem connections on government and commercial telephone lines as a backup method for the network. Additionally, selected computer generated products are received via the PC-Based Weather Facsimile (PCGRAFAX) System.

1.2.2 CONVENTIONAL DATA — These data sets are comprised of land and shipboard surface observations, enroute meteorological observations from commercial and military aircraft (AIREPS) recorded within six hours of synoptic times, and cloud-motion winds derived from satellite data. The conventional data are hand- and computer-plotted, and hand-analyzed in the tropics for the surface/gradient and 200-mb levels. These analyses are prepared twice daily from 0000Z and 1200Z synoptic data.

1.2.3 SATELLITE RECONNAISSANCE — Meteorological satellite imagery recorded at USAF/USN ground sites and USN ships supply day and night coverage in JTWC's AOR. Interpretation of this satellite data provides tropical cyclone positions and estimates of current and forecast intensities (Dvorak, 1984). The USAF tactical satellite sites and Air Force Global Weather Central (AFGWC) currently receive and analyze special sensor microwave/imager (SSM/I) data to provide locations of tropical cyclones of which the center is obscured by cirrus clouds, and estimates of 35-kt (18 m/sec) wind radii near tropical cyclones.

In addition, scatterometry data are retrieved over the computer network from the Naval Oceanographic Office (NAVOCEANO) (high resolution, small area depictions), and the Oceanic Sciences Branch (OSB), National Oceanic and Atmospheric Administration (NOAA) (lower resolution, large area depictions). This scatterometry data provides tropical cyclone positions and a graphical representation of the wind profile surrounding a tropical cyclone. It is also used in the twice daily surface/gradient hand-analysis performed at JTWC. Use of satellite reconnaissance is discussed further in section 2.3 Satellite Reconnaissance Summary.

1.2.4 RADAR RECONNAISSANCE — Land-based radar observations are used to position tropical cyclones. Once a well-defined tropical cyclone moves within range of land-based radar sites, radar reports are invaluable for determination of position, movement, and, in the case of Doppler radar, storm structure and wind information. JTWC's use of radar reports during 1994 is discussed in section 2.4 Radar Reconnaissance Summary.

1.2.5 AIRCRAFT RECONNAISSANCE — Until the summer of 1987, dedicated aircraft reconnaissance was used routinely to locate and determine the wind structure of tropical cyclones. Now, aircraft fixes are only rarely available from transiting jet aircraft or from weather reconnaissance aircraft involved in research missions.

1.2.6 DRIFTING METEOROLOGICAL BUOYS — In 1989, the Commander, Naval Meteorology and Oceanography Command (COMNAVMETOCCOM) put its Integrated Drifting Buoy Plan (1989-1994) into action to meet USCINCPACFLT requirements that included tropical cyclone warning support. In 1995, 30 drifting buoys were deployed in the western North Pacific by a Naval Oceanographic Office-contracted C-130 aircraft. Of the 30 buoys, 24 were Compact Meteorological and Oceanographic Drifters (CMOD) with temperature and pressure sensors and six were Wind Speed and Direction (WSD) drifters with wind speed and direction, temperature and pressure. The drifters were evenly split by type over two deployments - the first in June followed by the second in September. The purpose of the split deployment was to overlap the expected three month lifespans of the CMOD buoys in order to provide continuous coverage during the peak of the western North Pacific tropical cyclone season.

1.2.7 AUTOMATED METEOROLOGICAL OBSERVING STATIONS (AMOS) — Through a cooperative effort between the COMNAVMETOCCOM, the Department of the Interior, and NOAA/NWS to increase data available for tropical analysis and forecasting, a network of 20 AMOS stations is being installed in the Micronesian Islands (see Tables 1-1 and 1-2). Previous to this effort, two sites were installed in the Northern Mariana Islands at Saipan and Rota through a joint venture between the Navy and NOAA/NWS. The site at Saipan relocated to Tinian in 1992. Since September of 1991, the capability to transmit data via Service ARGOS and NOAA polar orbiting satellites has

Table 1-1 AUTOMATED METEOROLOGICAL OBSERVING STATIONS SUMMARY

Site	Location	Call sign	ID#	System	Installed
Saipan*	15.2°N, 145.7°E	15D151D2	-----	ARC	1986
Rota	14.2°N, 145.2°E	15D16448	91221	ARC	1987
Faraulep**	8.1°N, 144.6°E	FARP2	52005	C-MAN/ARGOS	1988
Enewetak	11.4°N, 162.3°E	ENIP2	91251	C-MAN/ARGOS	1989
Ujae***	8.9°N, 165.7°E	UJAP2	91365	C-MAN	1989
Pagan	18.1°N, 145.8°E	PAGP2	91222	C-MAN/ARGOS	1990
Kosrae	5.4°N, 163.0°E	KOSP2	91355	C-MAN/ARGOS	1990
Mili	6.1°N, 172.1°E	MILP2	91377	C-MAN	1990
Oroluk	7.6°N, 155.2°E	ORKP2	91343	C-MAN	1991
Pingelap	6.2°N, 160.7°E	PIGP2	91352	C-MAN/ARGOS	1991
Ulul	8.4°N, 149.4°E	NA	91328	C-MAN/ARGOS	1992
Tinian*	15.0°N, 145.6°E	15D151D2	91231	ARC	1992
Satawan	6.1°N, 153.8°E	SATP2	91338	C-MAN/ARGOS	1993
Ulithi	9.9°N, 139.7°E	NA	91204	C-MAN/ARGOS	1995
Ngulu	8.3°N, 137.5°E	NA	91411	C-MAN/ARGOS	1995

* Saipan site relocated to Tinian and commissioned on 1 June 1992.

** The prototype site on Faraulep was destroyed on 28 November 1991 by Super Typhoon Owen.

*** Ujae site was destroyed on 18 November 1992 by Super Typhoon Gay.

ARC = Automated Remote Collection system (via GOES West)

C-MAN = Coastal-Marine Automated Network (via GOES West or GMS)

ARGOS = Service ARGOS data collection (via NOAA's TIROS-N)

Table 1-2 PROPOSED AUTOMATED METEOROLOGICAL OBSERVING STATIONS

Site	Location	Installation	Delayed
Pulusuk	6.5°N, 149.5°E	1993	Yes*
Faraulep	8.6°N, 144.6°E	1994	Yes**
Eauripik	6.7°N, 143.0°E	1994	Yes**
Maloelap	8.7°N, 171.2°E	1994	Yes
Utirik	11.2°N, 169.7°E	1994	Yes
Satawal	7.4°N, 147.0°E	1995	Yes
Ujelang	9.8°N, 161.0°E	1995	Yes
Ebon	4.6°N, 168.7°E	1995	Yes
Maug	20.0°N, 145.2°E	1996	No

* Runway construction

** Testing of GMS transmission packages

been available as a backup to regular data transmission to the Geostationary Operational Environmental Satellite (GOES) West, and more recently for sites to the west of Guam, to the Japanese Geostationary Meteorological Satellite (GMS). Upgrades to existing sites are also being accomplished as the opportunity arises to enable access to the ARGOS. JTWC receives data from all AMOS sites via the AWN under the KWBC bulletin headers SMPW01, SIPW01 and SNPW01 (SXMY10 for Tinian and Rota).

1.3 TELECOMMUNICATIONS

Telecommunications support for the NPMOCW/JTWC is provided by the Naval Telecommunications Area Master Station, Western Pacific (NTWP) and their Base Communications Department. The NPMOCW/JTWC telecommunications link to NTWP is a new fiber optic cable which incorporates stand-by redundancy features. Connectivity includes "switched" secure and non-secure voice, facsimile, data services, and dedicated audio and digital circuits to NTWP. Telecommunications connectivity and the basic system configurations which are available to JTWC follow.

1.3.1 AUTOMATED DIGITAL NETWORK (AUTODIN) — AUTODIN currently supports the message requirements for JTWC, with the process of converting to the new Defense Messaging System (DMS) in progress. A personal computer (PC) system running the "Gateguard" software application provides transmit and receive message capabilities. Secure connectivity is provided by a dial-up Secure Telephone Unit-III path with NTWP.

The Gateguard system is used to access the AUTODIN/DMS network for dissemination of warnings, alerts, related bulletins, and messages to Department of Defense (DoD) and U.S. Government installations. Message recipients can retransmit these messages for further dissemination using the Navy Fleet Broadcasts, Coast Guard continuous wave (CW) Morse code, and text to voice broadcasts.

AUTODIN/DMS messages are also relayed via commercial telecommunications routes for delivery to non-DoD users. Inbound message traffic for JTWC is received via AUTODIN/DMS addressed to NAVPACMETOCCEN WEST GU//JTWC//.

1.3.2 AUTOMATED WEATHER NETWORK (AWN) — The AWN provides weather data over the Pacific Meteorological Data System (PACMEDS). JTWC uses two PC systems which run the Windows based WINDS/AWNCOM software application package to interface with a dedicated 1.2 kb/sec (kilo-bits per second) PACMEDS circuit. These PC systems provide JTWC the PACMEDS transmit and receive capabilities needed to effectively store and manipulate large volumes of alphanumeric meteorological data available from reporting stations throughout JTWC's AOR. The AWN also allows JTWC access to data which are available on the Global Telecommunications System (GTS). JTWC's AWN station identifier is PGTW.

1.3.3 AUTOMATED WEATHER DISTRIBUTION SYSTEM (AWDS) — The AWDS consists of two dual monitor workstations which communicate with a UNIX based communications/data server via a private Local Area Network (LAN). The server's data connectivity is provided by two dedicated long-haul data circuits. The AWDS provides JTWC with additional transmit and receive access to alphanumeric AWN data at Tinker AFB using a dedicated 9.6 kb/sec circuit. Access to satellite imagery and computer graphics from Air Force Global Weather Center (AFGWC) is provided by another dedicated 9.6 kb/sec circuit.

AWDS current configuration should be upgraded in the summer of 1996 to include improved workstation performance, and integration into NPMOCW's LAN backbone which has access to the Defense Information Systems Network's (DISN), Non-secure Internet Protocol (IP) Router Network's (NIPRNET) Wide Area Network (WAN). The LAN and WAN connectivity will allow JTWC to send and receive products among other AWDS systems. AWDS IP address information should be available third quarter 1996. Send email requests to jtops@npmocw.navy.mil for more information.

1.3.4 DEFENSE SWITCHED NETWORK (DSN) — DSN is a worldwide, general purpose, switched telecommunications network for the DoD. The network provides a rapid and vital voice and data link for JTWC to communicate tropical cyclone information with DoD installations and civilian agencies.

JTWC utilizes DSN to access DSN based users, FTS2000, SprintNET networks for commercial or non-DoD based users, and local commercial long distance carriers for voice and data requirements. These requirements include the pulling of Naval Oceanography Data Distribution System (NODDS) data, accessing Air Force Dial-In System (AFDIS), transmitting and receiving facsimile products, and as an alternate route for sending and receiving data to support the Automated Tropical Cyclone Forecast (ATCF) system requirements.

The DSN and commercial telephone numbers for JTWC are (671) 349-5240 or 349-4224. Note: the DSN area code for Pacific is 315.

1.3.5 TACTICAL ENVIRONMENTAL SUPPORT SYSTEM (3) (TESS(3)) — The TESS(3) is connected by NIPRNET WAN to FNMOC. NIPRNET connectivity is provided by a dedicated virtual switched data services 56 kb/sec packet switched data link. FNMOC's supercomputer generated gridded fields are pushed to the TESS(3) using NIPRNET, allowing for local value added tailoring of analyses and prognoses. The TESS(3) provides connectivity through NIPRNET to all COMNAVMETOCCOM (CNMOC) Centers world-wide.

1.3.6 NIPRNET—DISN's NIPRNET has replaced the DDN MILNET computer communications network, providing a much needed boost in throughput speed needed in the transfer of large data and image files. NIPRNET has links or gateways to the non-DoD Internet, allowing data to be pulled and pushed from Internet based World Wide Web (WWW) and File Transfer Protocol (FTP) servers. This capability has enhanced JTWC's ability to exchange data with the Internet based research community.

JTWC's products are currently available to users of the DISN based Secret IP Router Network (SIPRNET) using WWW browser software. JTWC's SIPRNET homepage address can be obtained by contacting JTWC's Operations Officer. Plans are to have an operational NIPRNET/Internet based WWW server in place by third quarter 1996.

JTWC's Internet email server's IP address is 192.231.128.1 and the email address is jtops@npmocw.navy.mil.

1.3.7 TELEPHONE FACSIMILE — TELEFAX provides the capability to rapidly scan and transmit, or receive, documents over commercial telephone lines or DSN. TELEFAX is used to disseminate tropical cyclone advisories and warnings to key agencies on Guam and, in special situations, to DoD, other U.S. Government agencies, and the other Micronesian Islands. Inbound documents for JTWC are received at (671) 349-6143, (671) 349-6101, or (671) 349-4032.

1.3.8 LOCAL USER TERMINAL (LUT) — JTWC uses a LUT, provided by the Naval Oceanographic Office, as the primary means of receiving real-time data from drifting meteorological buoys and ARGOS-equipped AMOS via the polar orbiting TIROS-N satellites.

1.4 DATA DISPLAYS

1.4.1 AUTOMATED TROPICAL CYCLONE FORECAST (ATCF) SYSTEM — The ATCF is an advanced software program that assists the Typhoon Duty Officer (TDO) in the preparation, formatting, and dissemination of JTWC's products. It cuts message preparation time and reduces the number of corrections. The ATCF automatically displays: the working and objective best tracks; forecasts of track, intensity, and wind distribution; and, information from computer generated forecast aids and products from other agencies. It also computes the myriad of statistics calculated by JTWC. Links have been established through a Local Area Network (LAN) to the NAVPACMETOCCEN WEST Operations watch team to facilitate the generation of tropical cyclone warning graphics for the fleet facsimile broadcasts, for NAVPACMETOCCEN WEST's local metwatch program, and for warning products for Micronesia. A module permits satellite reconnaissance fixes to be input from 36 OSS/OSJ into the LAN.

1.4.2 TESS(3) receives, processes, stores, displays and prints copies of FLENUMETOCCEN data and environmental products. It also ingests and displays satellite imagery from the Naval Meteorological Data Receiver-Recorder Set (SMQ-11) and other TESS(3) sets worldwide.

1.4.3 AWDS functions are similar to those of the TESS(3), but the environmental products and satellite global data base imagery are produced by AFGWC.

1.4.4 NAVAL OCEANOGRAPHIC DATA DISTRIBUTION SYSTEM (NODDS) — NODDS is a personal computer (PC)-based system that uses a telephone modem to download, store and display environmental and satellite data base products from FLENUMETOCCEN.

1.4.5 NAVAL SATELLITE DISPLAY SYSTEM - GEOSTATIONARY (NSDS-G) — The NSDS-G is NAVPACMETOCCEN WEST's primary geostationary imagery processing and display system. It can be used to process high resolution geostationary imagery for analysis of tropical cyclone positions and intensity estimates for the western Pacific Ocean should the the Meteorological Imagery, Data Display, and Analysis System (MIDDAS - see Chapter 2) fail.

1.4.6 PC-BASED WEATHER FACSIMILE (PCGRAFAX) SYSTEM — PCGRAFAX is a microcomputer-based system that receives, stores and displays analog and digital facsimile products that are transmitted over high frequency (HF) radio.

1.4.7 SATELLITE WEATHER DATA IMAGING SYSTEM (SWDIS) — The SWDIS (also known as the M-1000) is a PC-based system that interfaces with the LAN to retrieve, store, and display various products such as: geostationary satellite imagery from other NSDS-G sites at Rota (Spain), Pearl Harbor (Hawaii), or Norfolk (Virginia), scatterometer data from NAVOCEANO and NOAA, and composites of global geostationary satellite imagery from the Internet. The SWDIS has proven instrumental in providing METEOSAT reduced-resolution coverage of tropical cyclones over the western Indian Ocean.

1.5 ANALYSES

The JTWC TDO routinely performs manual streamline analyses of composite surface/gradient-level (3000 ft (914 m)) and upper-tropospheric (centered on the 200-mb level) data for 0000Z and 1200Z daily. Computer analyses of the surface, 925-, 850-, 700-, 500-, 400-, and

200-mb levels, deep-layer-mean winds, frontal boundaries depiction, 1000-200 mb/400-200 mb/and 700-400 mb wind shear, 500 mb and 700 mb 24-hour height change, and a variety of other meteorological displays come from the 0000Z and 1200Z FLENUMETOCCEN data bases. Additional sectional charts at intermediate synoptic times and auxiliary charts, such as station-time plot diagrams, time-height cross section charts and pressure-change charts, are analyzed during periods of significant tropical cyclone activity.

1.6 FORECAST PROCEDURES

1.6.1 INITIAL POSITIONING — The warning position is the best estimate of the center of the surface circulation at synoptic time. It is estimated from an analysis of all fix information received from one hour before to one and one-half hours after that synoptic time. The analysis is aided by a computer-generated objective best track scheme that weights fix information based on its statistical accuracy. The TDO includes synoptic observations and other information to adjust the position, testing consistency with the past direction, speed of movement and the influence of the different scales of motions. If the fix data are not available due to reconnaissance platform malfunction or communication problems, or are considered unrepresentative, synoptic data and/or extrapolation from previous fixes are used.

1.6.2 TRACK FORECASTING — In preparing the JTWC official forecast, the TDO evaluates a wide variety of information, and employs a number of objective and subjective techniques. Because tropical cyclone track forecasting has and continues to require a significant amount of subjective input from the TDO, detailed aspects of the forecast-development process will vary somewhat from TDO to TDO, particularly with respect to the weight given to any of the available guidance. JTWC uses a standardized, three-phase tropical cyclone motion forecasting process to improve not only track forecast accuracy, but also intensity forecast accuracy and forecast-to-forecast consistency.

1.6.2.1 Field Analysis Phase — Navy Operational Global Atmospheric Prediction System (NOGAPS) analyses and prognoses at various levels are evaluated for position, development, and movement of not only the tropical cyclone, but also relevant synoptic features such as: 1) subtropical ridge circulations, 2) mid-latitude short/long-wave troughs and associated weaknesses in the subtropical ridge, 3) monsoon surges, 4) influences of cyclonic cells in the Tropical Upper-Tropospheric Trough (TUTT), 5) other tropical cyclones, and 6) the distribution of sea surface temperature. This process permits the TDO to develop an initial impression of the environmental steering influences to which the tropical cyclone is and will be subjected to as depicted by NOGAPS. The NOGAPS analyses are then compared to the hand-plotted and analyzed charts prepared by the TDO and to the latest satellite imagery in order to determine how well the NOGAPS-initialization process has conformed to the available synoptic data, and how well the resultant analysis fields agree with the synoptic situation inferred from the imagery. Finally, the TDO compares both the computer and hand-analyzed charts to monthly climatology in order to make a preliminary determination of to what degree the tropical cyclone is, and will continue to be, subjected to a climatological or nonclimatological synoptic environment. Noting latitudinal and longitudinal displacements of subtropical ridge and long-wave midlatitude features is of particular importance, and will partially determine the relative weights given to climatologically- or dynamically-based objective forecast guidance.

1.6.2.2 Objective Techniques Analysis Phase — By applying the guidance of the "Systematic and Integrated Approach to Tropical Cyclone

Forecasting,"(Carr and Elsberry, 1994) the TDO can relate the latest set of guidance given by JTWC's suite of objective techniques with the NOGAPS model prognoses and currently observed meteorological conditions. This allows the TDO to evaluate the objective techniques guidance to the following principles.

First, the degree to which the current situation is considered to be, and will continue to be, climatological is further refined by comparing the forecasts of the climatology-based objective techniques, dynamically-based techniques, and past motion of the present storm. This assessment partially determines the relative weighting given the different classes of objective techniques.

Second, the spread of the set of objective forecasts, when plotted, is used to provide a measure of the predictability of subsequent motion, and the advisability of including a moderate probability alternate forecast scenario in the prognostic reasoning message or warning (outside the western North Pacific). The directional spread of the plotted objective techniques is typically small well-before or well-after recurvature (providing high forecast confidence), and is typically large near the decision-point of recurvature or non-recurvature, or during a quasi-stationary or erratic movement phase. A large spread increases the likelihood of alternate forecast scenarios.

1.6.2.3 Construct Forecast Phase — The TDO then constructs the JTWC official forecast giving due consideration to the: 1) extent to which the synoptic situation is, and is expected to remain, climatological; 2) past statistical performance of the various objective techniques on the current storm; and, 3) known properties of individual objective techniques given the present synoptic situation or geographic location. The following guidance for weighting the objective techniques is applied:

a) Weight persistence strongly in the first 12 to 24 hours of the forecast period.

b) Give significant weight to the last JTWC forecast at all forecast times, unless there is significant evidence to warrant a departure (also consider the latest forecasts from regional warning centers, if applicable).

c) Apply the "Systematic and Integrated Approach," (Carr and Elsberry, 1994) using conceptual models of recurring, dynamically-related meteorological patterns with the traits of the numerical and objective aid guidance associated with the specific synoptic situation.

1.6.3 INTENSITY FORECASTING — The empirically derived Dvorak (1984) technique is used as a first guess for the intensity forecast. The TDO then adjusts the forecast after evaluating climatology and the synoptic situation. An interactive conditional climatology scheme allows the TDO to define a situation similar to the system being forecast in terms of location, time of year, current intensity, and intensity trend. Synoptic influences such as the location of major troughs and ridges, and the position and intensity of the TUTT all play a large part in intensifying or weakening a tropical cyclone. JTWC incorporates a checklist into the intensity forecast procedure. Such criteria as upper-level outflow patterns, neutral points, sea-surface temperatures, enhanced monsoonal or cross-equatorial flow, and vertical wind shear are evaluated for their tendency to enhance or inhibit normal development, and are incorporated into the intensity forecast process. In addition to climatology and synoptic influences, the first guess is modified for interactions with land, with other tropical cyclones, and with extratropical features. Climatological and statistical methods are also used to assess the potential for rapid intensification (Mundell, 1990).

1.6.4 WIND-RADII FORECASTING — Since the loss of dedicated aircraft reconnaissance in 1987, JTWC has turned to other data sources for determining the radii of winds around tropical cyclones. The determination of wind radii forecasts is a three-step process:

a) First, low-level satellite drift winds, scatterometer and microwave imager 35-kt wind speed analysis (see Chapter 2), and synoptic data are used to derive the current wind distribution.

b) Next the first guess of the radii is determined from statistically-derived empirical wind radii models. JTWC currently used three models: the Tsui model, the Huntley model, and the Martin-Holland model. The latter model uses satellite-derived parameters to determine the size and shape of the wind profile associated with a particular tropical cyclone. The Martin-Holland model also incorporates latitude and speed of motion to produce an asymmetrical wind distribution. These models provide wind distribution analyses and forecasts that are primarily influenced by the intensity forecasts. The analyses are then adjusted based on the actual analysis from step a), and the forecasts are adjusted appropriately.

c) Finally, synoptic considerations, such as the interaction of the cyclone with mid-latitude high pressure cells, are used to fine-tune the forecast wind radii.

1.6.5 EXTRATROPICAL TRANSITION — When a tropical cyclone moves into the mid-latitudes, it often enters an environment that is detrimental to the maintenance of the tropical cyclone's structure and energy-producing mechanisms. The effects of cooler sea surface temperatures, cooler and dryer environmental air, and strong vertical wind shear all act to convert the tropical cyclone into an extratropical cyclone. JTWC indicates that this conversion process is occurring by stating that the tropical cyclone is "becoming extratropical." JTWC will indicate that the conversion is expected to be complete by stating that the system has become "extratropical." When a tropical cyclone is forecast to become extratropical, JTWC coordinates the transfer of responsibility with the appropriate regional NAVPACMETOCCEN, which assumes warning responsibility for the extratropical system.

1.6.6 TRANSFER OF WARNING RESPONSIBILITY — JTWC coordinates the transfer of warning responsibility for tropical cyclones entering or exiting its AOR. For tropical cyclones crossing 180° E longitude in the North Pacific Ocean, JTWC coordinates with the Central Pacific Hurricane Center (CPHC), Honolulu via the Naval Western Oceanography Center (NAVPACMETOCCEN), Pearl Harbor, Hawaii. For tropical cyclones crossing 180° E longitude in the South Pacific Ocean, JTWC coordinates with the NAVPACMETOCCEN, which has responsibility for the eastern South Pacific. Whenever a tropical cyclone threatens Guam, files are electronically transferred from JTWC to the Alternate Joint Typhoon Warning Center (AJTWC) collocated with NAVPACMETOCCEN. In the event that JTWC should become incapacitated, the AJTWC assumes JTWC's functions. Assistance in determining satellite reconnaissance requirements, and in obtaining the resultant data, is provided by the weather unit supporting the 15th Air Base Wing, Hickam AFB, Hawaii.

1.7 WARNINGS

JTWC issues two types of warnings: Tropical Cyclone Warnings and Tropical Depression Warnings.

1.7.1 TROPICAL CYCLONE WARNINGS — These are issued when a closed circulation is evident and maximum sustained 1-minute winds are forecast to reach 35 kt (18 m/sec) within 48 hours, or when the tropical cyclone is in such a position that life or property may be endangered within 72 hours.

Each Tropical Cyclone Warning is numbered sequentially and includes the following information: the current position of the surface center; an estimate of the position accuracy and the supporting reconnaissance (fix) platform(s); the direction and speed of movement during the past six hours (past 12 hours in the Southern Hemisphere); and the intensity and radial extent of over 35-, 50-, and 100-kt (18-, 26-, and 51-m/sec) surface winds, when applicable. At forecast intervals of 12, 24, 36, 48, and 72 hours (12, 24, and 48 hours in the Southern Hemisphere, (72 hours as required)), information on the tropical cyclone's anticipated position, intensity and wind radii is provided. Vectors indicating the mean direction and mean speed between forecast positions are included in all warnings. In addition, a 3-hour extrapolated position is provided in the remarks section.

Warnings in the western North Pacific and North Indian Oceans are issued every six hours (unless an amendment is required), valid at standard times: 0000Z, 0600Z, 1200Z and 1800Z (at a minimum every 12 hours: 0000Z, 1200Z or 0600Z, 1800Z in the Southern Hemisphere). All warnings are released to the communications network no earlier than synoptic time and no later than synoptic time plus two and one-half hours, so that recipients are assured of having all warnings in hand by synoptic time plus three hours (0300Z, 0900Z, 1500Z and 2100Z). By area, the warning bulletin headers are: WTIO31-35 PGTW for northern latitudes from 35° to 100° east longitude, WTPN31-36 PGTW for northern latitudes from 100° to 180° east longitude, WTXS31-36 PGTW for southern latitudes from 35° to 135° east longitude, and WTPS31-35 PGTW for southern latitudes from 135° to 180° east longitude.

1.7.2 TROPICAL DEPRESSION WARNINGS — These are issued only for western North Pacific tropical depressions that are not expected to reach the criteria for Tropical Cyclone Warnings, as mentioned above. The depression warning contains the same information as a Tropical Cyclone Warning except that the Tropical Depression Warning is issued every 12 hours (unless an amendment is required) at standard synoptic times and extends in 12-hour increments only through 36 hours.

Both Tropical Cyclone and Tropical Depression Warning forecast positions are later verified against the corresponding best track positions (obtained during detailed post-storm analyses) to determine the most probable path and intensity of the cyclone. A summary of the verification results for 1995 is presented in Chapter 5, Summary of Forecast Verification.

1.8 PROGNOSTIC REASONING MESSAGES

These plain language messages provide meteorologists with the rationale for the JTWC forecasts for tropical cyclones in the western North Pacific Ocean. They also discuss alternate forecast scenarios, if changing conditions indicate such potential. Prognostic reasoning messages (WDPN31-36 PGTW) are prepared to complement tropical cyclone (but not tropical depression) warnings. In addition to these messages, prognostic reasoning information may be provided in the remarks section of a warning message.

1.9 TROPICAL CYCLONE FORMATION ALERTS

Tropical Cyclone Formation Alerts are issued whenever interpretation of satellite imagery and other meteorological data indicates that the formation of a significant tropical cyclone is likely. These alerts will specify a valid period, usually not exceeding 24 hours, and must either be canceled, reissued, or superseded by a warning prior to expiration. By area, the Alert bulletin headers are: WTIO21-25 PGTW for northern latitudes from 35° to 100°E longitude, WTPN21-26 PGTW for northern latitudes from 100° to 180°E longitude, WTXS21-26 PGTW for southern latitudes from 35° to 135°E longitude, and WTPS21-25 PGTW for southern latitudes from 135° to 180°E longitude.

1.10 SIGNIFICANT TROPICAL WEATHER ADVISORIES

This product contains a description of all tropical disturbances in JTWC's AOR and their potential for further (tropical cyclone) development. In addition, all tropical cyclones in warning status are briefly discussed and referenced.

Two separate messages are issued daily, and each is valid for a 24-hour period. The Significant Tropical Weather Advisory for the Western Pacific Ocean is issued by 0600Z. The Significant Tropical Weather Advisory for the Indian Ocean is issued by 1800Z. These are reissued whenever the situation warrants. For each suspect area, the words "poor", "fair", or "good" are used to describe the potential for development. "Poor" will be used to describe a tropical disturbance in which the meteorological conditions are currently unfavorable for development. "Fair" will be used to describe a tropical disturbance in which the meteorological conditions are becoming more favorable for further development (i.e. improving), but significant development has not commenced. "Good" will be used to describe the potential for development of a disturbance covered by an Alert. By area, the advisory bulletin headers are: ABPW10 PGTW for northern latitudes from 100° to 180°E longitude and southern latitudes from 135° to 180°E longitude and ABIO10 PGTW for northern latitudes from 35° to 100°E longitude and southern latitudes from 35° to 135°E longitude.

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